

Reducing Manpower for a Technologically Advanced Ship

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Overview

Reducing Manpower on a Technologically Advanced Ship

- **Challenges**
- **“Total System” approach**
- **Enablers for success**

Challenges Experienced - DDG 1000

- Numerous Ship System Design “Firsts”
- Highly constrained system technical and programmatic requirements
- Unprecedented concurrency and complexity

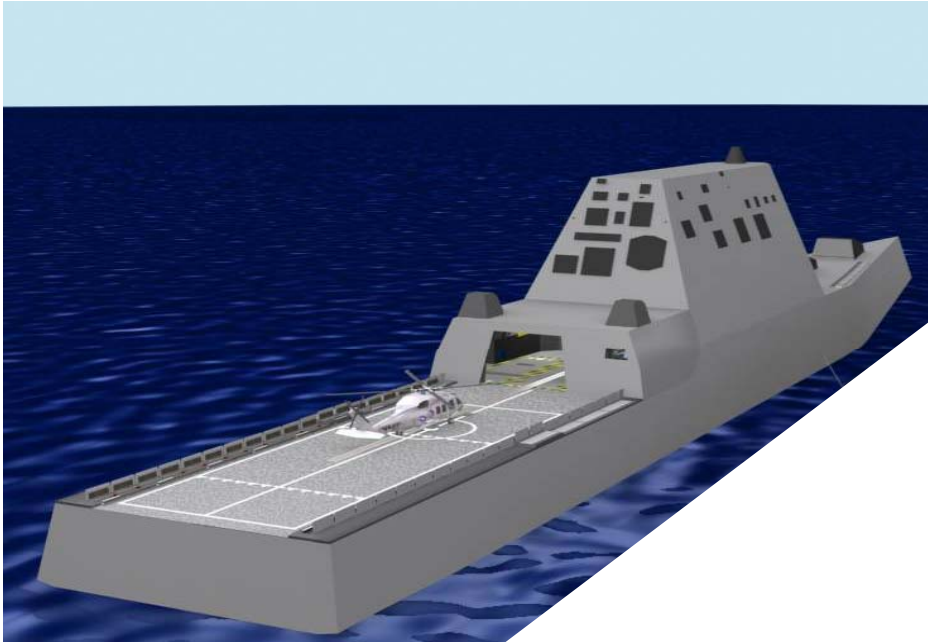


Ship System Design “Firsts”

- A single prime contractor, leading to Critical Design Review
 - Responsible for entire ship, combat/mission system and shore support
- Ship contract design not performed by the Navy
- Ten new technologies introduced with Baseline Design
- Production planning performed directly from 3D model, not drawings
- Ship manning dramatically reduced (350+ to <150)



DDG 1000 Requirements



Key Performance Parameters

Net-Ready

Number of Guns

Gun Magazine Capacity

Vertical Launch Cells

Radar Cross Section

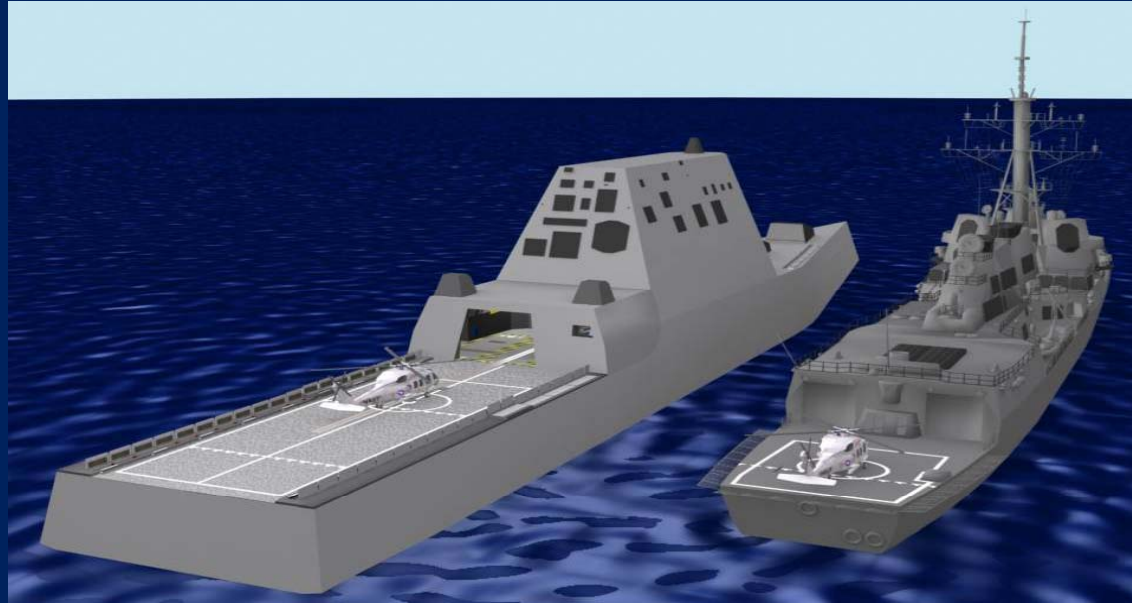
Manning

Survivability

Force Protection

- Carry the war to the enemy through offensive operations and destroy enemy targets ashore with precision strike and volume fires
- Contribute to littoral dominance: surface, air, sub-surface
- Employ an open architecture total ship computing approach
- Be highly survivable
- Reduce crew size

DDG 1000 / DDG 51 Flight IIA Comparison



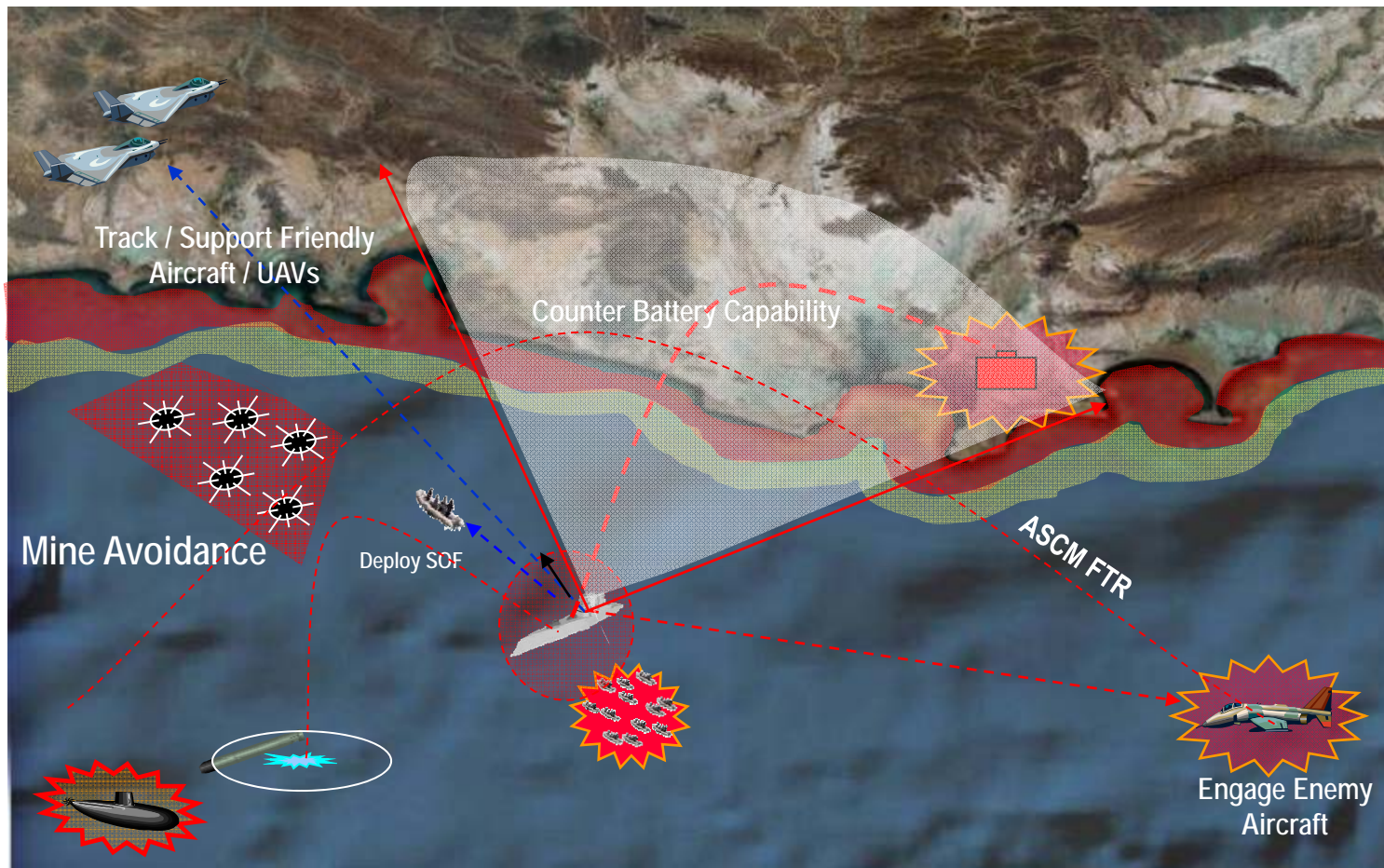
DDG 1000

Displacement	15,105 LT
Length / Beam	600 ft / 80.7 ft
Draft	28 ft
Crew Size	148

DDG 79

Displacement	9,217 LT
Length / Beam	509 ft / 67 ft
Draft	31 ft
Crew Size	314

Multi-Mission Combatant



**DDG 1000 delivers capability while
meeting Crew Size KPP**

DDG 1000 Critical Technologies

Dual Band Radar (DBR)



Advanced Gun System (AGS)/Long Range Land Attack Projectile (LRLAP)



Composite Deckhouse & Apertures Test Article



Peripheral Vertical Launch System (PVLS) / Advanced VLS



Integrated Power System (IPS)



Autonomic Fire Suppression System (AFSS)



Total Ship Computing Environment (TSCE)

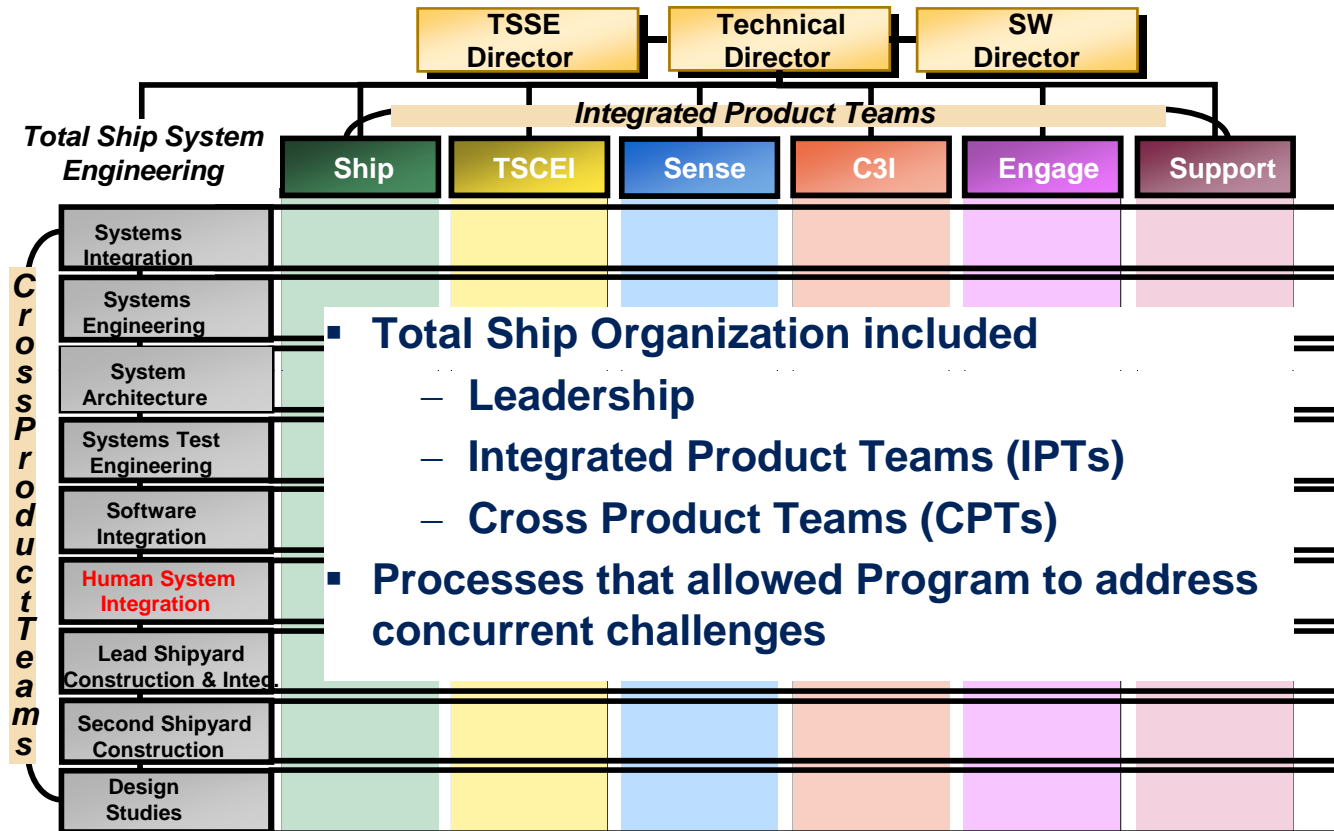


Hull Form Scale Models

Integrated Undersea Warfare (IUSW)

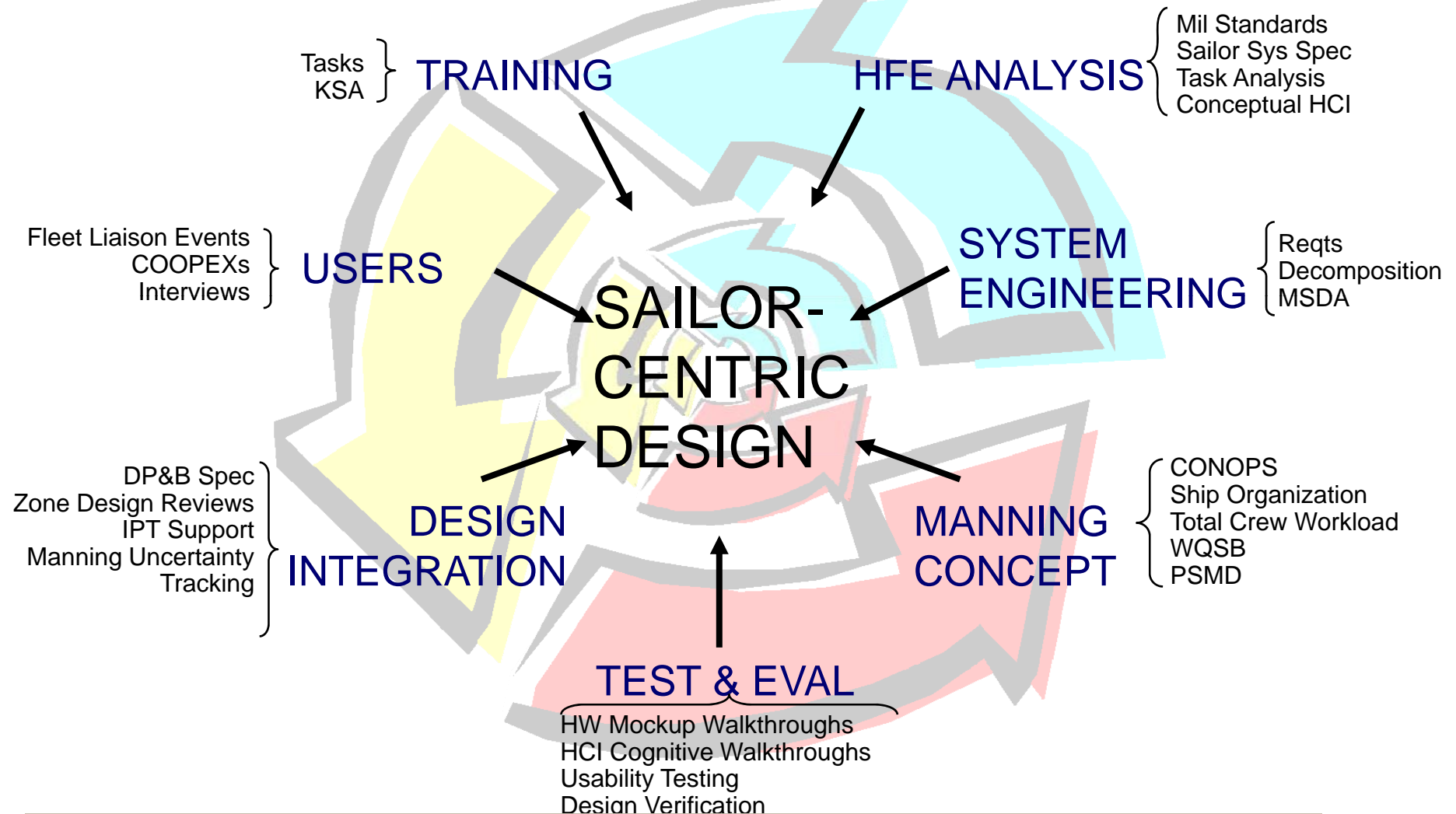


Total Ship Organization



Program concurrency and complexity necessitated
Total Ship System Engineering (TSSE)

Human System Integration (HSI) Summary



HSI is an inter-linked, repetitive process that spirals toward a sailor-centric design

Task Analysis Supports Crew Modeling

Days	Hours	Minutes	clock	Evolution #	Evolution Type	Num Going	Participating Crewmember Billets				
1	12	30	45000	3	ASTAC		001560				
1	13	0	46800	4	GQ Drill Brief		000020	002060	000200	000580	000680
1	13	45	49500	5	Crash Salvage Drill Brief		000680	001220			
1	15	0	54000	6	Helo Flight Quarters		001200	000760	000780	000620	000120
1	15	30	55800	9	GQ Drill		002200	001320	001340	001420	001440
1	17	30	63000	12	GQ Drill Debrf		000120	000320	000360	000400	000500
1	19	0	68400	1	OPS Brief		000020	000080	000160	001460	002060
1	19	30	70200	2	Eight Ocloc Reports		000020	000080	000160	001460	002060
2	6	30	109800	13	Man Overboard Drill Brief		000580	000040			
2	7	30	113400	14	Replenishment Brief		001600	000020	000620	001100	000140

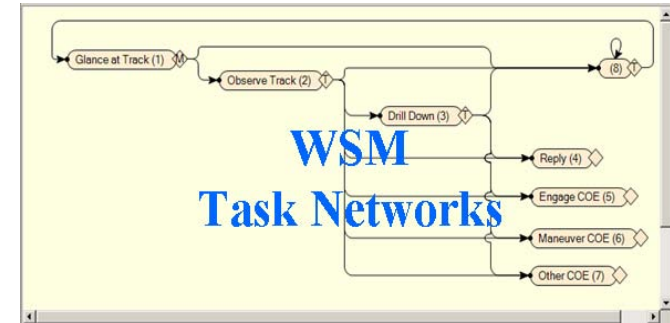
Total Crew Model

- Crew Workload
- Crew Rest
- Crew Fatigue
- Evolution Success
- Represents WQSB

TASK_NUM	TASK_NAME	WORKLOAD_CATTASK	CATTASK_TYPTASK_DESC
19	Receive Order to create a call for action - Operational Manning / Casualty AGS Mission	Operational Manning / Casualty	Identify The operator receives a call for action leading to by determining if the voice is an authentic source act.
23	Communicate with offboard assets to verify information	Operational Manning / Casualty	Communicate The operator communicates with offboard assets to verify information and complete the Call for Action Mission.
25	Authenticate CFA message	Operational Manning / Casualty	Assess The L&W-C verifies that the information in the CFA message is authentic.

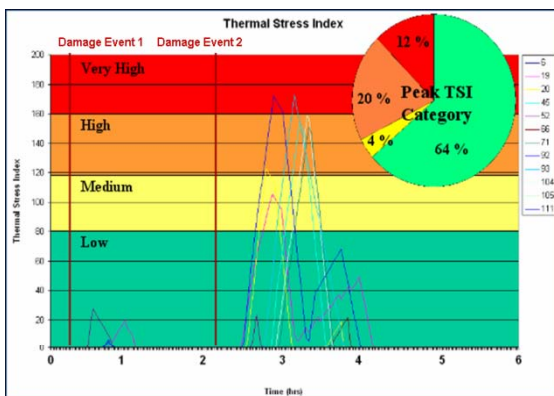
Task Repository

- Task ID
- Timing Requirements
- VCAP



Watchstander Model

- Watchstander Workload
- Measures of Performance
- Task Completion



DC Manning Model

- Thermal Stress
- Workload Drivers
- DC Manning Concept

UNREP Manning Model

- Transfer Rates
- Evolution duration
- Bottlenecks

UNREP Scenario Parameters

Transfer Rates

Galleons of DFM to transfer: Galleons of DFM per minute:

Galleons of JPS to transfer: Galleons of JPS per minute:

Galleons of Water to transfer: Galleons of Water per minute:

Cargo Replenishment

Number of AGS Ammo Containers to transfer:

Number of SIB Containers to transfer:

Number of Pallets to transfer:

Number of Retrograde Containers to transfer to CLF Ship:

Vertical Replenishment

Number of AGS Ammo Containers to transfer:

Number of SIB Containers to transfer:

Number of Pallets to transfer:

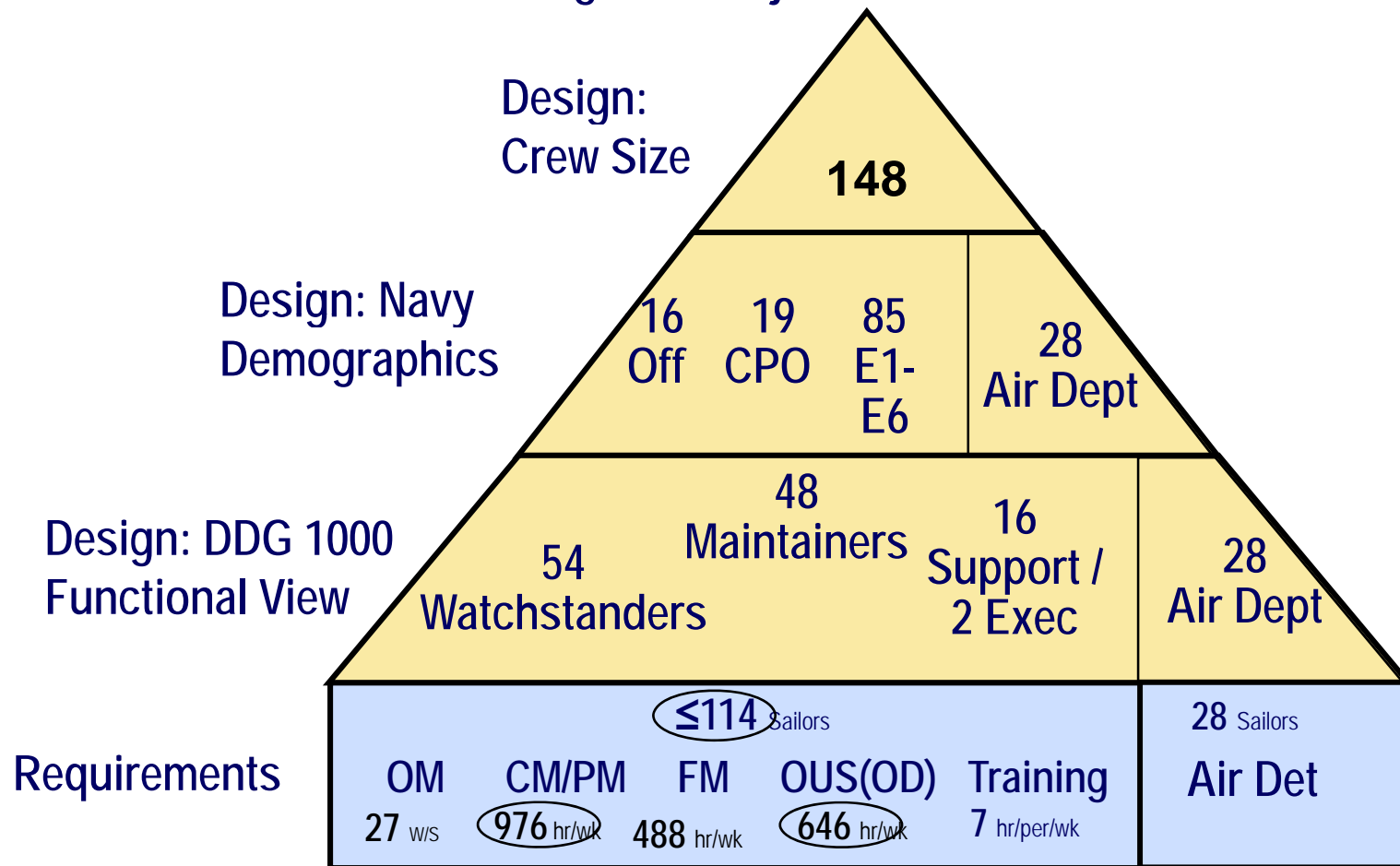
Number of Retrograde Containers to transfer to CLF Ship:

Number of Retrograde Containers per load:

OK

Workload and Watchstation Requirements

Manning KPP: Objective 125 – Threshold 175



DDG 1000 IUSW Watch Stander Approach



Undersea Warfare Specialist 1



Sea Combat Coordinator



Undersea Warfare Specialist 2

Enabling Technology

- Alert driven Active and ISMA operations
- Remote control of MFTA depth changes
 - Manual deployment to and retrieval from 150' cable scope
- Intuitive display design to improve workflow process
- Fusion at IUSW sensor and combat system level

Search → Detect, Classify, Locate → Engage



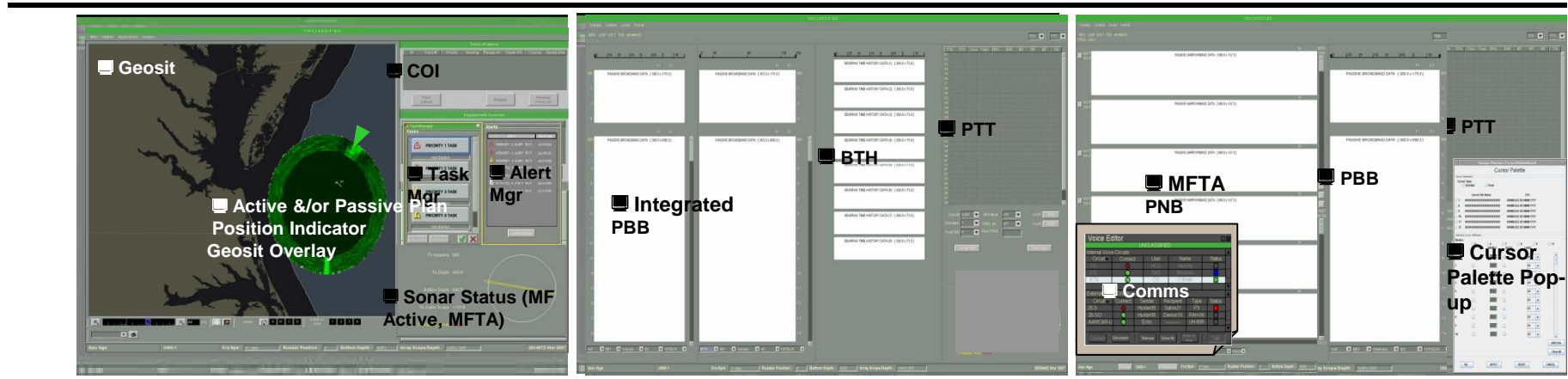
Focus shifts to follow the threat

Focuses on maintaining situational awareness, plus threat evaluation / prosecution

Focus remains on searching for new/additional threats

**DDG 1000 w/ 5 Crew vs. DDG 51 w/ 10 Crew
for Condition III ASW and Mine Avoidance**

User Centric Human Computer Interface



- Efficient use of three displays on multi-modal workstation
 - Multiple security domains deployed to single workstation
- Break down sensor → processing → display “stovepipes” at the workstation
- Deliver all screens required by IUSW watchstander to complete his/her tasks
 - Acoustic drilldown, system management, communications, situation awareness
- Conduct frequent assessments with active Fleet participants
 - Feed recommendations back into design

Condition III Operational Manning

Flt IIA SMD Watchstations		DDG 1000 Watchstations	
Bridge	5	Bridge	2
CIC	26	Ship Mission Center	16
Eng Spaces	8	Eng Spaces	0
CSMC	6	CSMC	0
Radio/LAN	4	Radio	0
Total	49	Total	18

Supporting Analysis

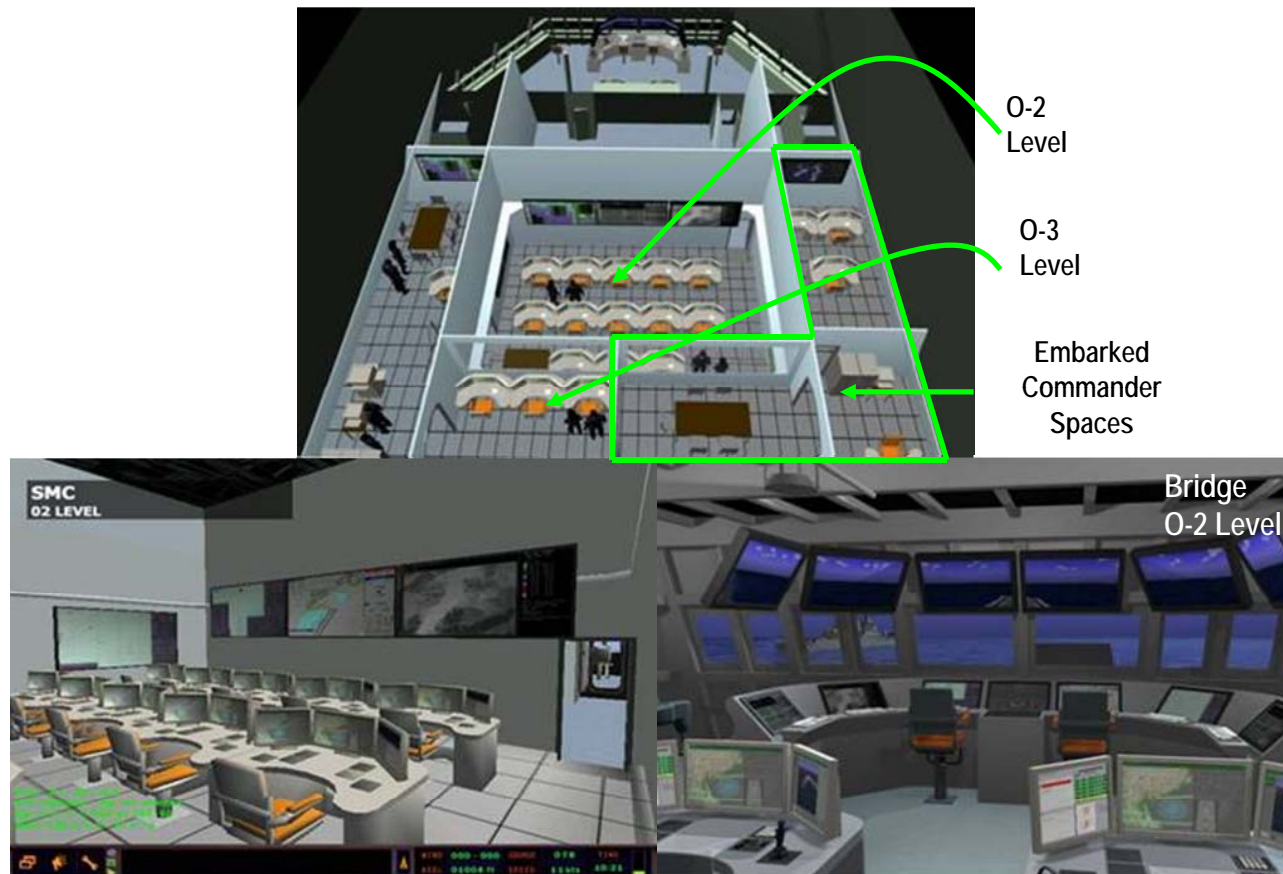
- Mission System Design Analysis (MSDA) and Task Analysis
- HSI Crew Design Gap Analyses
- Watchstander Model (WSM)
- Usability Engineering
 - Bridge and SMC COOPEXs
 - Watch Station HCI UT
- SCI SMC Assessment

Enabling Design Features

- User-Centered Human Computer Interface (HCI)
- TSCEI – Common processors and network
 - Single operating system
 - Common Display System
 - Extensive Virtual Presence
- Automation in Readiness Assessment
 - Remote monitor / control of HME
 - Extensive Virtual Presence
 - Mission Readiness Support System (MRSS)
- Equipment Health Monitoring
- Advanced Sensor Suites

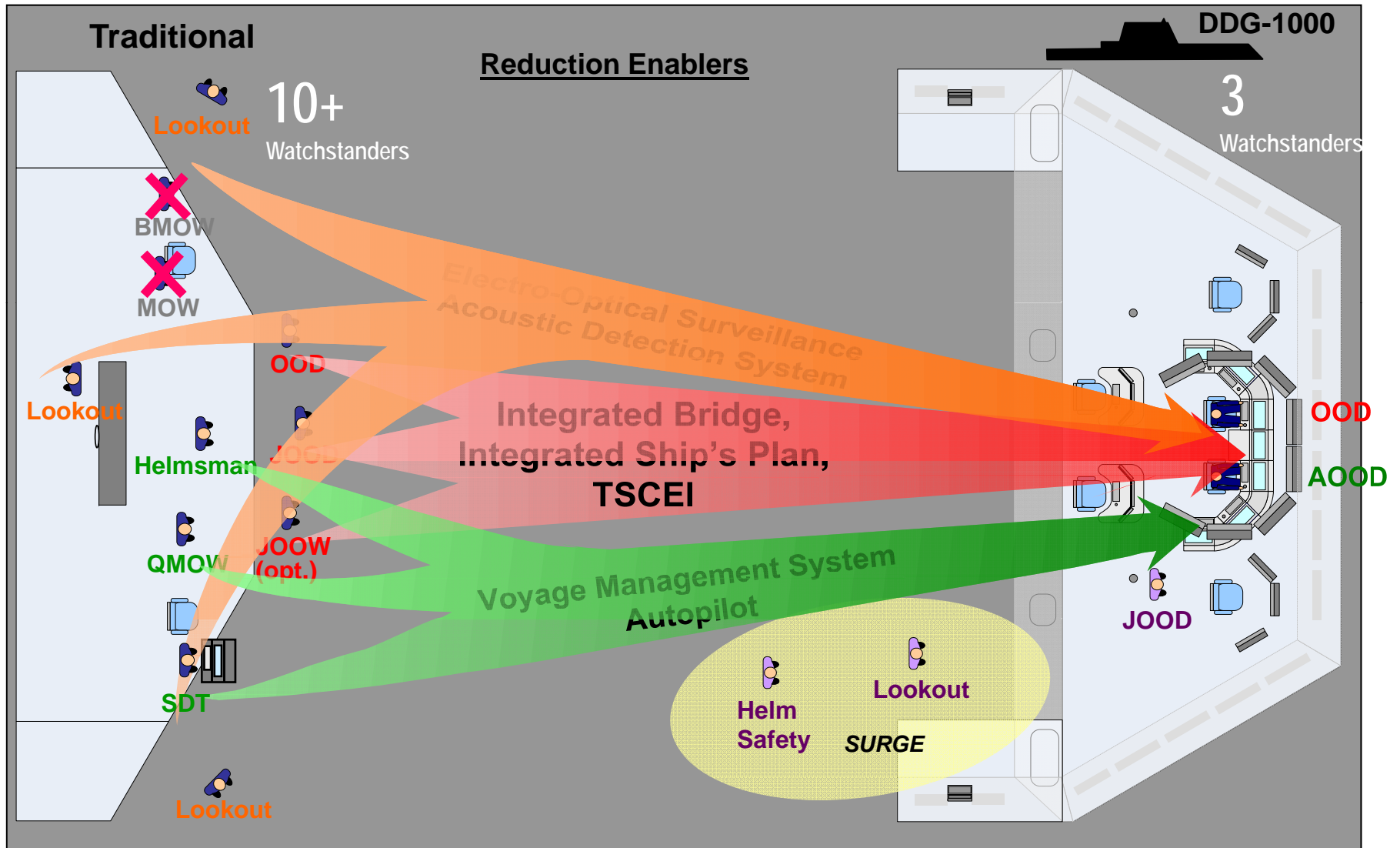
Reduced Condition III Watchstations by 67% (49 to 18)

Ship's Mission Center / Integrated Bridge



DDG 1000 Operates w/ 18 Crew vs. DDG 51 w/ 54 Crew for Condition III

Bridge Operations - Watchstanders



Special Evolutions – Simultaneous VERTREP, CONREP, FAS

Flt IIA Watchstations		DDG 1000 Watchstations	
CONREP (1 Station)	28	CONREP (1 Station)	6
FAS (1 Station)	28	FAS (1 Station)	6
Strikedown	120	Strikedown	12
VERTREP	27	VERTREP	8
Engineering	7	Engineering	2
Total	* 210	Total	* 34

*Includes Firefighting

Supporting Analysis

- Special evolution studies
- Aviation and SIB fleet liaison events
- UNREP Discrete event model (DTB1-110)
- Total Crew Model (DTA1-110, DTB1-110)

Enabling Design Features

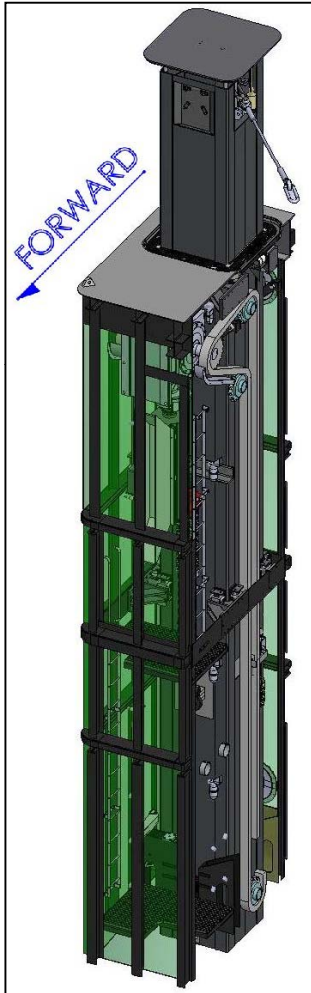
- Retractable Sliding King Post
- Anchor handling system
- Single point wireless communication
- Optimized use of RFID and Asset Management System
- Forklift transport
- High resolution surveillance
- Cargo handling passageway
- AGS handling system

VERTREP = Vertical Replenishment
CONREP = Connected Replenishment
FAS = Fueling at Sea

Reduced Special Evolutions Watchstations by 84% (210 to 34)

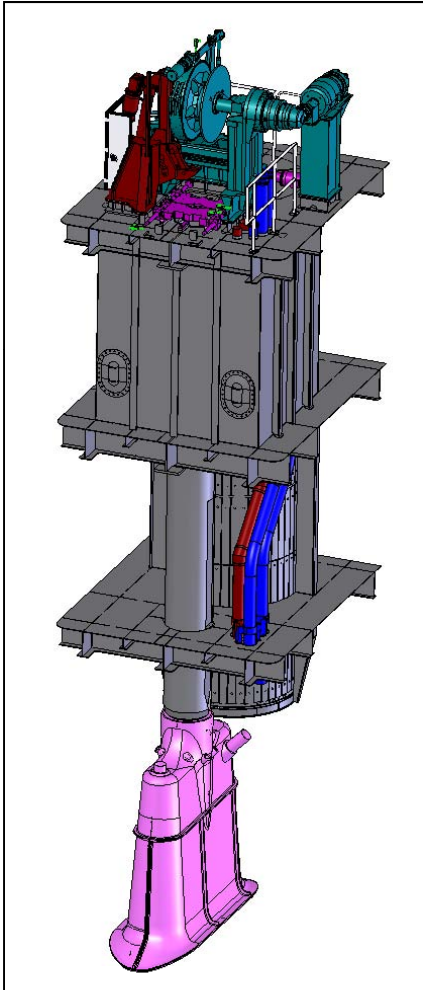
APL

Retractable Sliding King Post



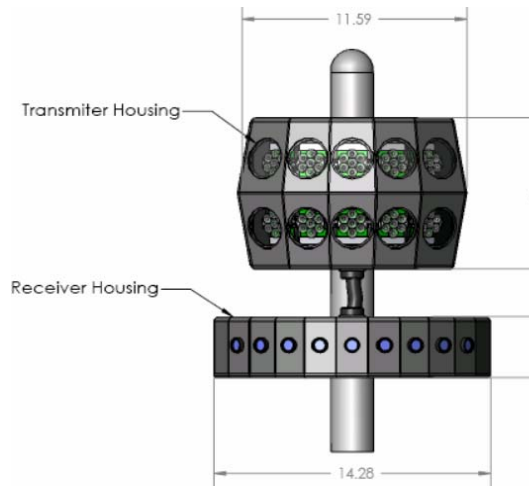
- Provides a higher sea-state-control of the load as it is being lowered to the deck by retracting the kingpost with each load transferred
 - Allows more load control with fewer personnel
- Taller than existing kingposts
 - Allows for greater clearances throughout a greater range of off-station angles
- Utilizes electric motor that raises and lowers the kingpost structure using chains and sprockets
 - Contributes to greater and more precise load control as the load clears the ship's deck edge
- All rigging attachments mounted to the kingpost and not to surrounding deck and house structure

Anchor Handling System (AHS)

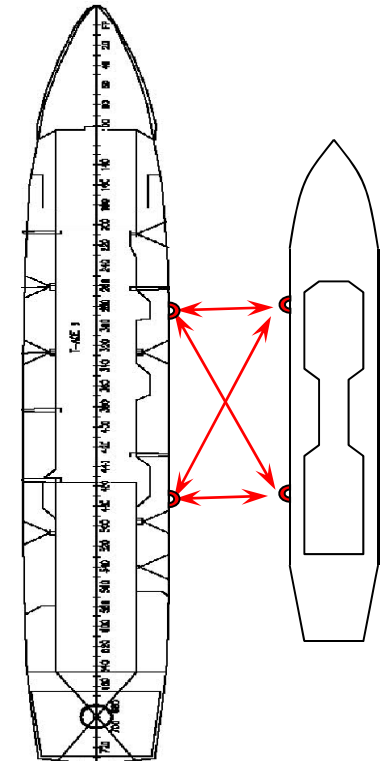


- Contains all functions of traditional anchor handling system
- Electrically driven
- Wash down system of nozzles cleans anchor and chain as it enters the AHS
- AHS control station minimizes manning
- Modular design for “drop in” installation

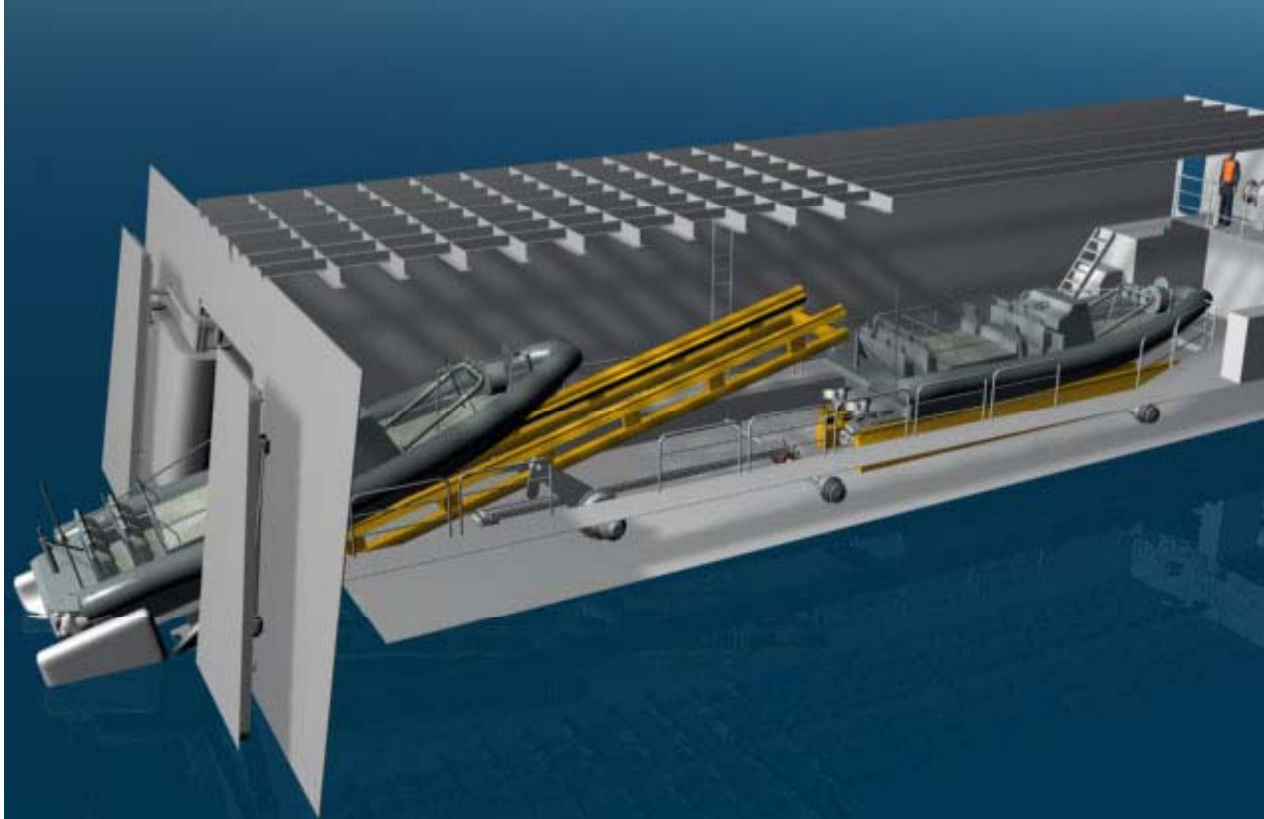
Phone and Distance Line Replacement



- **6-PAQ transceiver units**
 - Use eye-safe IR LED Free Space Optics (FSO)
 - Transmit and receive signals over a horizontal range of 180 degrees and a vertical range of 120 degrees
 - Range provides 500+ feet ship separation
- **Multiple transceivers on each ship**
 - Redundant communications paths
 - Accuracy of a few inches

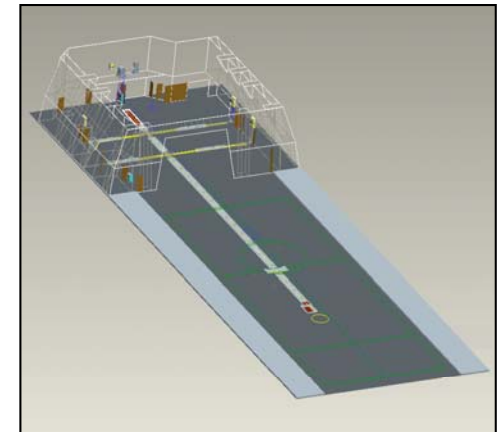
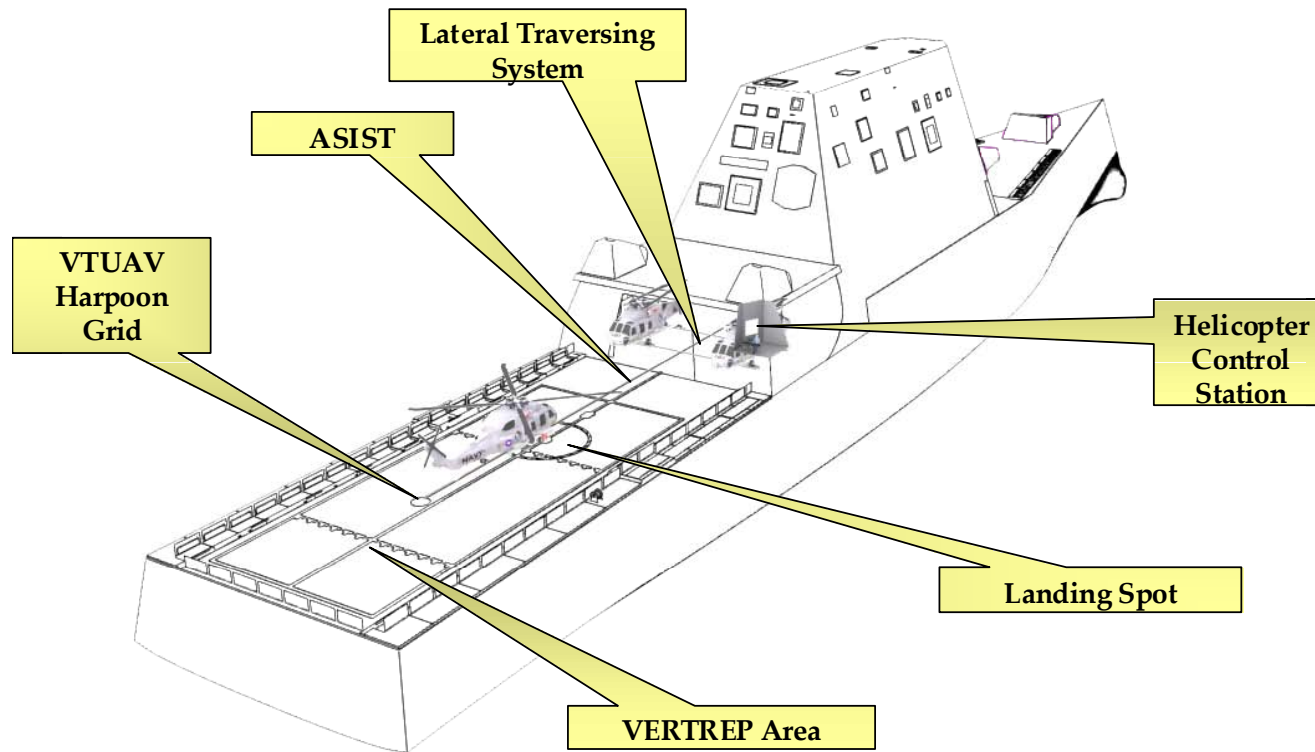


Boat Handling System



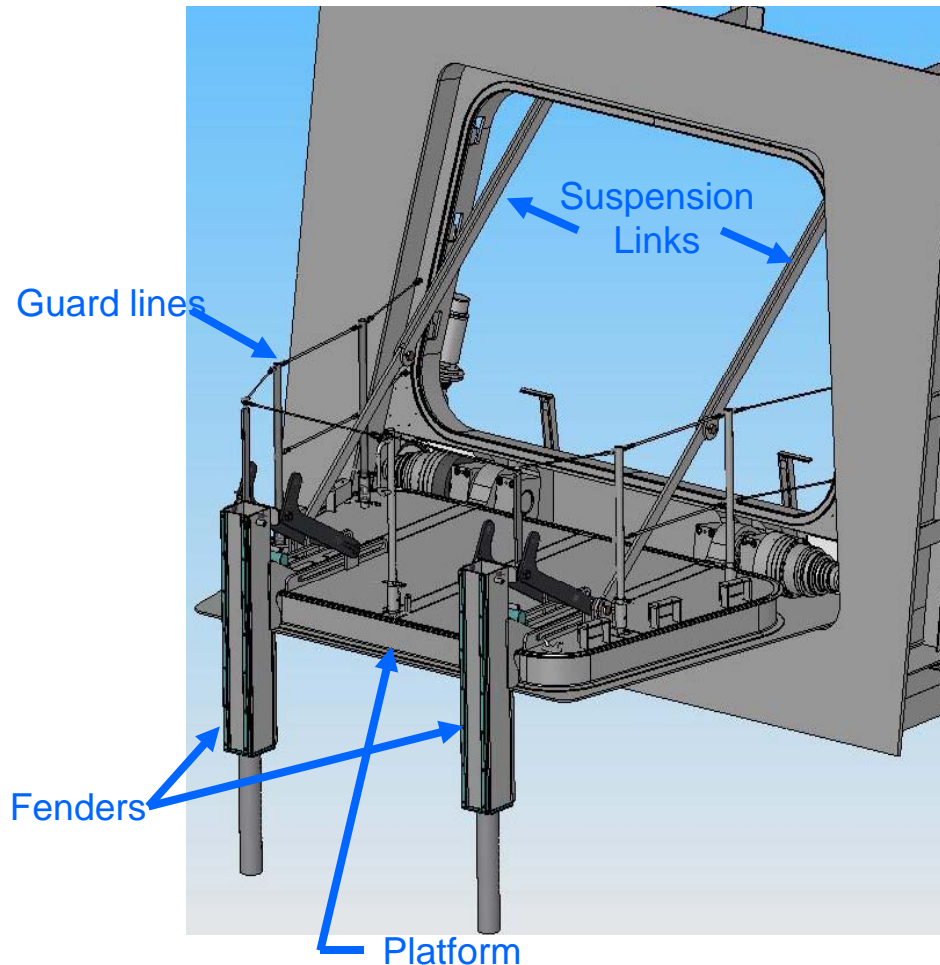
- **Stern launch and retrieval system**
 - Launch/retrieve through sea state 5
 - Capabilities for three RHIB variants, two 11m RHIBs, and one 7m RHIB (space reservation)
- **Extendable ramp is buoyant and will match wave action angle**
 - Provide smooth transition into boat bay with relative 10 kts RHIB speed

Aircraft Handling and Securing System (AHSS)



- Integrated system that remotely
 - Captures aircraft (A/C)
 - Guides A/C to the deck,
 - Translates A/C into the hangar,
 - Moves A/C laterally inside hangar to stowage position

Embarkation Platform



- Machinery is electrically operated and weather tight, requiring low maintenance
- Delivered with guard lines that provide personnel protection
- Allows operations through sea state 3 with fendering feature

Damage Control

Flt IIA SMD Watchstations		DDG 1000 Watchstations	
Condition I	119	Condition I	85
Condition II*	48+	Condition II	42
Condition III*	11	Condition III	7**

*Estimated, not in SMD

** Initial Rapid Response Team (RRT)

Supporting Analysis

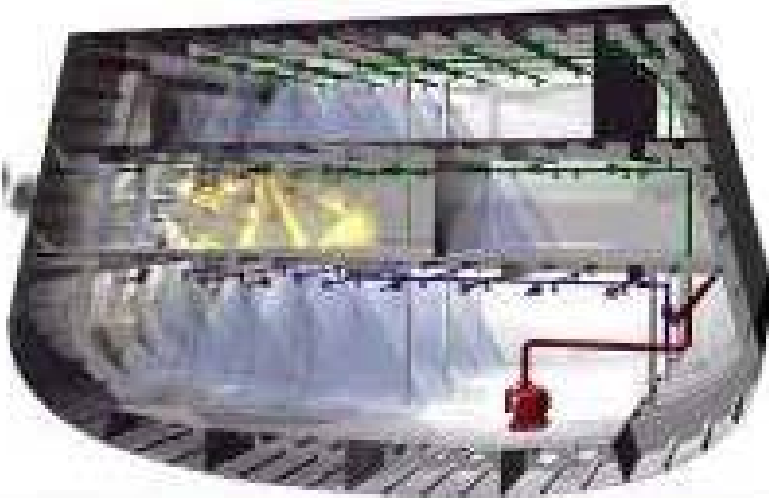
- DC ARM (98-01)
- USS SHADWELL AFSS EDM Tests
- DT event ATG Norfolk (Fleet Review)
- SWOS Newport DCA School Review
- Fleet/ATG SME Review
- Missile/Mine Hit CCOEs
- DTB1-110 DC Manning Model

Enabling Design Features

- **Autonomic Fire Suppression System (AFSS)**
- **Smart valves – isolation**
- **Advanced sensor suites**
- **Virtual presence**
- **Personnel locating system**
- **TSCEI communications**
- **Damage decision and assessment**
- **Automated de-watering**
- **Maximum vulnerability control**
 - **Zones: Fire protection, electrical, CPS**
 - **Smoke control**

Reduced DC Condition I Watchstations by 84% (119 to 34)

“Autonomic” Fire Suppression System



- AFSS is designed to automatically:
 - (1) Isolate damage to firemain piping components,
 - (2) Detect fire, smoke and heat conditions,
 - (3) Activate suppression systems and
 - (4) Suppress fires using a variety of suppression systems including water mist for suppressing peacetime machinery space fires and combat induced fires and sprinkling for magazines



TeleroBotic Fire Nozzle (TFN)



Spot/ Smoke Heat



Optical Flame Detector



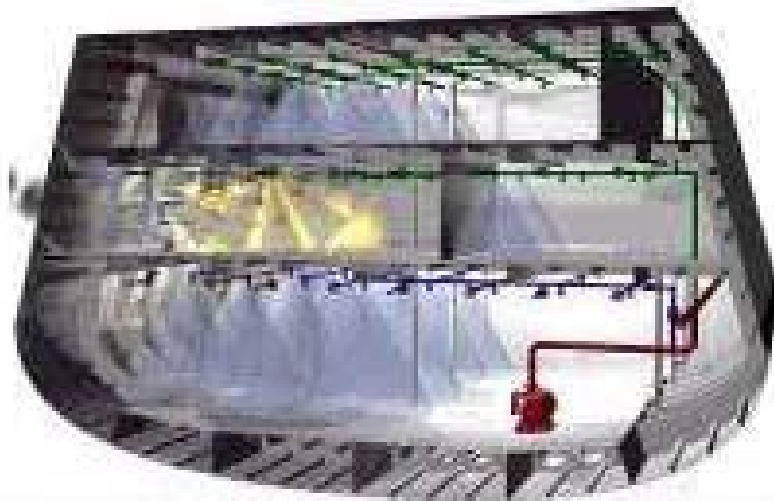
Linear Heat Detector



Smoke Aspiration

DDG-1000 Fire Detection Sensors

“Autonomic” Fire Suppression System



CM / PM Workload

Flt IIA SMD Hr/Wk On-Board		DDG 1000 Hr/wk On-Board	
Operators	476	Operators	20
Maintainers	1350	Maintainers	864.5
Support	76	Support	4
Total *	1902	Total **	888.5

* Includes (15%) Make Ready Put Away (MRPA)

WSTR request CM / PM WL Allocation Increase to ~ 1080 m-hr/wk

Supporting Analysis

- **Supportability Workload and Reliability, Maintainability, & Availability (RMA)**
- **Analysis of alternatives**
- **Top 10 Driver Reduction**
- **Knowledge, Skills and Abilities (KSA) focused task analysis for targeted equipment**
- **Crew Design Gap Analysis (DMS, SC, SA Support)**

Enabling Design Features

- **Condition Based Maintenance (CBM)**
- **Comprehensive equipment health monitoring**
- **Increased equipment reliability**
- **Lowest Replaceable Unit (black box replacement)**
- **On-demand training support**
- **Shore support**
- **Automated magazine monitoring**
- **Automated Identification Technology (AIT)**

Reduced CM / PM Workload by 53% (1902 to 889)

Facilities Maintenance (FM) Workload

Flt IIA SMD Hr/Wk On-Board		DDG 1000 Hr/Wk On-Board	
Operators	343	Operators	33
Maintainers	199	Maintainers	274
Support	564	Support	135
Ship Total	1106	Ship Total	442
Shore	0	Shore	395
Total	1106	Total	837

Supporting Analysis

- **Compartment-level workload analysis by HSI CPT**
- **Advanced tool assessment**
- **KSAs determined for tasks**
- **Appropriate detail throughout the Design Build Specification**

Enabling Design Features

- **CBM**
- **Reduced hydraulics**
- **Material Selection**
 - Improved deck coatings
 - Corrosion resistant coatings
 - Corrosion resistant fasteners
- **General Arrangements**
 - Improved air filtration
 - Freshwater flushing
- **Shore Support**
 - Augment for all preservation
 - Augment for periodic deep cleaning
- **Enhanced / Advanced tools**
 - HEPA filter type vacuum
 - Disposable toilet wands
 - “Grease cutting” spray / wipes
 - “Enhanced personal responsibility” training

Reduced Facilities Maintenance hrs/wk by 60% (1106 to 442)

Own Unit Support (OUS)

Flt IIA Manning		DDG 1000 Manning	
CS/FSA	24	CS/FSA	9
SK	9	SK	2
SH	5	SH	2
YN/PN	5	YN/PN	1
HM	3	HM	1
DK/PC/NC	3	DK/PC/NC	0
Total	49	Total	13

Supporting Analysis

- Food service discrete event model
- Food service fleet liaison events
- Smart ship galley data collection
- Food service task evaluation
- Shipboard evaluations of OUS tasks and workload (DDG 89, 91, CG 53)

Enabling Design Features

- **Advanced food service system-approach**
 - Centralized galley
 - Streamlined Inventory Control / Automated provisions access
 - Advanced pre-prepared foods
 - Advanced Equipment Suite
 - No FSA but specific evolution / space cleaning assist.
- Streamlined (flexible-delivery) personal services concepts
- Automated Information Technology (AIT)
- Advanced telemedicine

Reduced Own Unit Support Crew by 73% (49 to 13)

Training

Per 1000.16J Hr/wk/Billet		DDG 1000 Hr/wk/Billet	
Training	7	Accounted for by OM or Other Work	6.73
		Not Accounted for by OM or Other Work	5.01
Total	7	Total (Average)	11.74

Supporting Analysis

- Fully assessed surface force training manual and SORM for all exercises and courses
- Training categories analyzed
 - Proficiency Training (PT), Cross Training (CT), Team Training (TT), Exercise Hours, Course Hours, Administrative Training, Training Administration, Physical Readiness Training (PRT)
- Variations of training analysis
 - Deployed (sustaining quals)
 - Inter deployment period (attaining qualifications and team forming, etc.)

Enabling Design Features

- CBM
- Library multimedia center
- Automated electronic learning classroom
- Enhanced team training
- Secondary Ship's Mission Center (SSMC)
- SMC Briefing / Debriefing Room
- Learner Model
- Adaptive Training
- Integrated Training System
- Integrated Learning Environment
- Homeport Training Facilities

Summary

Reducing Manpower on a Technologically Advanced Ship

- **Challenges**
 - Requirements, acquisition approach, CAIV, ...
 - Culture acceptance of deviations from current policies
- **“Total System” approach**
 - Commitment to a rigorous sailor-centric process throughout engineering and development
- **Enablers for success**
 - Workload task analyses that support a Total Crew Model
 - Design decisions that considered manning
 - Application of technologies